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BETHESDA MD 20814
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May 31, 1982
Volume 60, Number 22
CENEAR 60 (22) 1–56
ISSN 0009-2347

Chemical & Engineering NEWS

Cover: Maze of glassware is part of New England Nuclear's Boston facility for making radioactive chemicals

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Superfund to help clean up PCB-laced soil

They're called midnight dumpers. Last year four of them were convicted in federal court for deliberately releasing in 1978 more than 30,000 gal of waste transformer oil laced with polychlorinated biphenyls along 211 miles of highway shoulders in North Carolina. Last week, with superfund money, the Environmental Protection Agency agreed to help the state clean up this unique hazardous waste dump.

With nearly $2.6 million from EPA plus the $285,000 it already has spent, North Carolina will remove and dispose of a staggering 40,000 cubic yards of PCB-contaminated soil from highway shoulders in 14 counties. The soil will be buried in a secured landfill now being built in Warren County, solely to receive the PCB-laden waste. The state plans to complete the landfill in seven weeks. William Phillips of the state's Department of Transportation says the contaminated soil will not be pretreated before burial.

Additionally, the state is developing a detailed soil sampling and analysis plan to aid in the safe removal of the soil. No unreasonable risk to the environment or public health is expected from the cleanup. A trial run of the soil removal procedures in 1978 uncovered no adverse air or water effects.

Cleanup is expected to be completed by this fall. That includes reconstruction of the excavated highway shoulders as well as landfill construction and soil removal and disposal.

According to EPA Administrator Anne M. Gorsuch, the agency has approved nearly $54 million in superfund money. Approval has been given for remedial cleanup at 53 of the 115 top priority sites listed by EPA seven months ago. EPA public affairs officer Hagan Thompson says that $2.5 million is the largest sum of superfund money awarded in Region IV, the EPA region in which North Carolina is located. □

Venture weds computer and biotechnologies

International Plant Research Institute's (IPRI) founder and now former president, Martin A. Apple, is leaving to start a new venture, one that will try to wed the best of computer technology and biotechnology. This kind of management shuffling—some might call it upheaval, whereas others prefer the milder term transition—is another example of what's characterizing the young biotechnology industry (C&EN, March 29, page 10).

IPRI, located in San Carlos, Calif., has grown rapidly during the past few years. It's devoted to agricultural research and development, has assembled a multidisciplinary team of scientists for conducting such work, and currently is valued privately at more than $100 million, C&EN has learned. Management changes to accommodate this rapid growth apparently have been in the works since at least early this year.

The upshot is that Apple, who earned a reputation for outspokenness on IPRI's behalf, is leaving. A major shareholder in the company, he is expected to remain on the board of directors and also to serve the board as a consultant.

Apple plans to start up a new company, to be called EAN-TECH, which derives from an old English usage meaning to wean and to give birth to new lambs. The new company is intended to satisfy what Apple has called his persistent "itch to innovate." With seed money from Apple and a small group of private investors, EAN-TECH most assuredly will need to innovate to satisfy its purported mission of combining the world of computers with that of biotechnology. For example, the company will try to design improved and novel bioactive substances by relying partly on computer-guided design, much as is being attempted for the design of new drugs. Plans for the new company, which is to be staffed by a small group of researchers who can understand one another's disciplines, are being kept vague (if not secretive) to discourage would-be imitators. □

C&EN staff photo

Apple: an itch to innovate

Polyester shakeout stirs recovery hopes

There may be light at the end of the tunnel for the textile polyester filament industry, after all—and not the headlight of an oncoming train. The tunnel has been a long one for this important fiber, with a producer shakeout since the mid-1970s.

Producers have been cheered by the latest moves by Celanese in this business. Earlier this month, the company announced that as of August, it will close 200 million lb per year of polyester filament spinning capacity for partially oriented yarn. And last week, it took the relatively bold step—for the second largest U.S. supplier—of raising prices on partially oriented yarns 12 cents per lb, effective July 19. Celanese also announced that it would eliminate discounts on partially oriented yarns for the export market.

In general, polyester-filament producers were in agreement that something had to give in the business, which was beset by serious overcapacity. Capacity utilization had slumped to about 70% of nameplate capacity in the first quarter of 1982.

Celanese's shutting down 200 million lb of capacity—nearly half of the 450 million lb of filament capacity it has, by some estimates—will trim total industry capacity for textile polyester filament roughly 14%, to 1.25 billion lb per year, giving a sizable boost to effective capacity utilization. Du Pont remains the largest supplier, with an estimated 660 million lb per year of filament yarn capacity. After Celanese, the capacity falls off quickly, to about 110 million lb for American Enka, perhaps 105 million lb for American Hoechst, 90 million lb for Eastman Kodak, and 35 million to 40 million for Avtex.

Some industry sources contend that the pricing in polyester filament was in serious shape. Price discounting was heavy, even for branded fibers. A typical list price (in the U.S.)

Polyester filament has slumped in shipments . . .

Millions of lb	March 1982	April 1981	% change
Industrial	27.8	29.0	−4.1%
Low-denier industrial	1.9	2.9	−34.5
Textile	86.5	123.6	−28.4
TOTAL	118.2	155.5	−23.7%

. . . and in utilization of plant capacity

	1st-qtr 1982	3rd-qtr 1981	1st-qtr 1981
% of nameplate capacity	70%	93%	82%
% of effective capacity	74	99	87

was about $1.05 a lb, with discounted prices going as low as 85 cents a lb.

Other producers feel that the problem wasn't really a case of massive price erosion, as one puts it, but a normal "give and take" of small lots of fiber being discounted during slow times. The reason for the sluggishness, besides general U.S. economic conditions, is a slowdown in exports. Exports had been doing well because of major sales to China, both by U.S. producers and others throughout the world. But the Chinese recently curtailed their buying. Producers surmise that they bought more than they needed, so now they have to get inventories under control. Suppliers don't see any major resumption of sales to China until probably late this fall.

Ironically, although producers cheer Celanese's actions as positive for the immediate health of the industry, one spokesman takes a less sanguine long-term view: "When the market turns around—and it will—there will be demand but not enough capacity to really take care of it."

Other producers, however, feel that any shortages would be brief, particularly in the U.S., as suppliers shifted from export sales to domestic sales. Similarly, they say that on a worldwide basis, if demand comes roaring back, there may be some temporary shortages, but capacity would be added quickly. □

No cancer link found in formaldehyde study

An epidemiologic study of cancer mortality among Du Pont employees who had worked with formaldehyde has shown no excess of cancer deaths in comparison to other employees.

Du Pont medical director Bruce W. Karrh says that the results of the study are consistent with findings from other epidemiology studies and suggest that formaldehyde hasn't caused cancer in humans. Karrh further says that the results support the company's conclusion that airborne levels of 1-ppm time-weighted-average and a 2-ppm ceiling provide adequate employee protection.

Du Pont began the study in 1980. Earlier, in 1979, preliminary results of a long-term inhalation study at the Chemical Industry Institute of Toxicology, Research Triangle Park, N.C., had indicated that formaldehyde is a carcinogen in rats. At that point, three of 120 male rats exposed for 16 months to 15 ppm of formaldehyde for six hours per day five days per week had developed squamous cell carcinoma in nasal passages. This earlier study, incidentally, was a major factor in the recent controversial ban on use of urea-formaldehyde foam insulation in schools and homes (C&EN, March 29, page 34).

For their study, Du Pont epidemiologists analyzed cancer deaths from 1957 through 1979 at eight plants that make or use formaldehyde. Among all present and former employees during that period, 481 deaths were from cancer, including 142 who potentially were exposed to formaldehyde.

The data were analyzed by tumor site, latent period, duration of exposure, exposure level and frequency, cumulative exposure index, age and year of death, and year of first exposure. Adjustments were made to lung cancer deaths for cigarette smoking habits.

Analysis found that cancer mortality rates in the formaldehyde workers were no higher than those among workers not involved with formaldehyde. The study found no cases of nasal cancer and no excess of lung cancer.

Slight, but statistically nonsignificant, elevation in relative risks were noted in the study for prostatic and bladder cancers, Du Pont says. However, it adds, these elevations showed no indications of being related causally to formaldehyde and appeared to be due to chance. □

Gulf Resources proxy fight nears climax

In June, an infrequent—for the chemical industry—major proxy fight could end for control of Houston-based Gulf Resources & Chemical. This particular battle is rare indeed; the dissidents stand a chance of winning, from early evidence in the voting.

The vote took place at Gulf Resources' annual meeting May 11, but certification of the results has been delayed into June by court order. Gulf Resources has about 45% of its sales in lithium chemicals, industrial explosives, fertilizers, and salt.

In late May, the dissident group, headed by Alan E. Clore, an investor and British citizen, appeared to have received the larger share of votes cast, about 55% of nearly 6.3 million. Review, examination, and challenges of the proxies (voting rights given by shareholders to the two principals) have been going on at CT Corp., a Wilmington, Del., company specializing in corporate election inspections.

The dissident group, called Gulf Resources & Chemical Corp. Committee for New Management, with Clore as chairman, wants to restructure the company to get maximum value of the stock for stockholders. On why it is making such an effort, the group particularly cites rejection in February 1980 of an outside acquisition offer of $42.12 per share for the company's common stock. This offer was way above the market price then and now. In late May, Gulf Resources stock was selling at about $17 a share.

In August 1981, the current Gulf Resources management, headed by chairman Robert H. Allen, began shutting down its money-losing nonferrous metals mining, smelting, and refining operations. Low prices for lead, zinc, and silver had led to losses in these operations in a subsidiary, Bunker Hill Co.

As a result of the shutdown of Bunker Hill, Gulf Resources took a one-time loss of more than $90 million in 1981. Earnings from continuing operations were $12.5 million.

Whether any or all of the various parts of Gulf Resources will remain if the dissident group becomes the new management is unknown, according to a spokesman for the group. If the group does win, it says that it immediately will begin studies of the company's assets and consider strategies for redeployment. □

Supply problems cloud outlook for radioisotopes

Availability of separated stable isotopes, raw material for most radioisotopes, is being hampered by both equipment, budget problems

Stephen C. Stinson
C&EN, New York

The worldwide synthetic radioisotopes industry is expanding at an impressive pace. Radiopharmaceuticals sales will come to $130 million in the U.S. this year and about $200 million worldwide, growing 15% annually. Radiochemicals for research are a $40 million market in this country and $65 million worldwide, increasing 7% per year.

Medical research continues to develop new diagnostic techniques using radioisotopes hitherto unthought of. U.S. radioisotope production capacity is expanding vigorously, while government agencies of other countries are adding to present capacity or installing their first facilities.

But the cloud of a possible raw materials shortage hangs over all this prosperity. With the exception of transuranium elements, synthetic radioisotopes are produced by neutron irradiation or ion bombardment of separated stable isotopes. Of the 83 elements from hydrogen to bismuth, 20 are monoisotopic in nature, two are synthetic radioisotopes, and stable isotopes of 11 are available in relatively large amounts from distillation, diffusion, or chemical exchange plants. For the remaining 50 elements, the only reliable source of separated stable isotopes in the world is a bank of 30 electromagnetic separators called calutrons at Oak Ridge National Laboratory in Tennessee operated by Union Carbide for the Department of Energy.

The problem is that the calutrons were installed in 1943 and need an overhaul badly. Too, limited budgets, combined with a recent reassignment of trained workers to a second bank of calutrons to separate radioisotopes for weapons production, have reduced stable isotopes separation to 50% of capacity. The result is that Oak Ridge is running behind in supplying demand. Of 240 stable isotopes of 50 elements, Oak Ridge is out of stock of 60, with no prospects of replenishing inventories of most of these for years.

The stable isotope supply situation has alarmed three communities of Oak Ridge customers—U.S. research scientists, U.S. radiopharmaceutical makers, and foreign customers of all kinds—who may come to blows over their mutually conflicting interests. Researchers use stable isotopes for their own sakes as tracers or in studies of nuclei. Collectively, they usually need to buy minute amounts of any and all of the 240 stable isotopes, or borrow them from the Oak Ridge research materials collection for nondestructive studies. Radiopharmaceuticals producers need kilogram amounts of half a dozen stable isotopes. Their needs take up 80% of current available calutron time.

Additional electromagnetic separation plants exist in the U.S.S.R. and Israel. The Soviets sell in the U.S. through Kolon Trading Co., New York City. A bank of calutrons thought to be located in Kharkov separates a wide variety of isotopes. Customers tell C&EN that quality is good and the price is right, but they fear disruptions in supply due to future possible political quarrels between the two governments. The Israelis occasionally offer a few isotopes in the U.S., separated using excess capacity on units used for research, but customers complain that prices are too high.

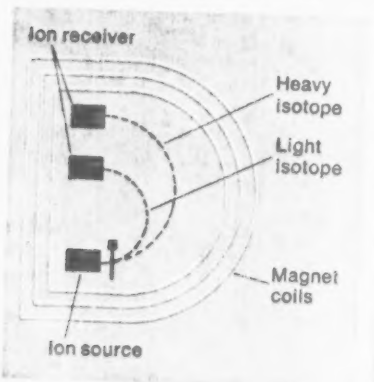
One solution would be for DOE simply to increase the budget for the Oak Ridge calutrons and recover the increase from sales. Oak Ridge isotopes section head Eugene Newman says such a move would enable him to restore adequate inventories of all isotopes and meet customer demands for many years. Other observers doubt DOE will take this simple way out and fear that present budgets actually will be cut. They note that government officials see the calutrons only as a cost, do not relate operating costs and sales revenues, and cannot budget for expenses in one year that will be recovered in future years.

The National Research Council's committee on chemical sciences brought representatives of Oak Ridge's research, clinical, and manufacturing customers together in February at a meeting sponsored by DOE and the National Institutes of Health. In a report published by NRC in mid-May, a panel of commercial customers indicated the possibility of forming a consortium to lease one calutron from Oak Ridge, supply capital to renovate it, send in their own crew to operate it, and use the output to supply their needs. The commercial panel also suggested that companies supply Oak Ridge with an annual list of their needs to schedule more orderly production. Many U.S. company representatives believe that Oak Ridge should adopt a policy of selling to foreign buyers only surpluses over and above U.S. firms' needs. But leasing a calutron to private users may be alien to DOE's philosophy. And rationing isotope sales could become an explosive political issue to foreign buyers, most of whom are government agencies.

Recommendations of three panels of research and clinical customers included a board representing all user communities to advise DOE on production scheduling and priority of inventory replenishment and increased funding for calutron operation. All four panels urged exploration of alternative methods of isotope enrichment of heavily used elements to take the load off the calutrons. Indeed, G. Sargent Janes, vice president for isotope research at Avco Everett Research Laboratory, Everett, Mass., says his company can adapt its technology for laser-induced photoionization of atoms of one isotope followed by electrostatic collection, to such heavily used isotopes. Janes estimates the project would take two to three years and cost $1 million for research and development and $2 million to build a pilot plant. And physics professors Mahadevan Krishman and Jay L. Hirshfield of Yale University, New Haven, Conn., described their technique of ionizing volatile compounds with rf, followed by centrifugation of the plasma in a magnetic field. They estimate costs of one such unit at $1.4 million.

Such alternative methods, if realized, might be built only by DOE. The few million dollars needed to develop

Calutrons most versatile for isotope separations



and install them may be too much for any one firm. Among radiopharmaceutical producers contacted by C&EN, only Marvin Stolberg, president of New England Nuclear, Boston, has considered such a project seriously, possibly by laser.

That there is any stable isotope supply problem at all is due largely to fruitfulness of radiopharmaceutical research, which has created a demand for cyclotron-produced radioisotopes in the past decade. Ten years ago, reactor-produced isotopes were the mainstay of nuclear medicine. Irradiation of an alloy of aluminum and enriched uranium-235 with neutrons, for example, produces molybdenum-99 and xenon-133 among the fission products. Xenon-133 is a beta-emitter with a 5.25-day half-life, used for imaging in lung ventilation studies. Molybdenum-99, nicknamed "fission moly," is fabricated into generators, where it decays by beta emission with a half-life of 66 hours to technetium-99m, which nuclear physicians elute from the generator. The m in the name of this isotope means metastable, which refers to the nuclear excited state in which this isotope is produced. When combined with various ligands, technetium-99m finds use in brain, liver, bone and kidney scans, as well as heart function studies.

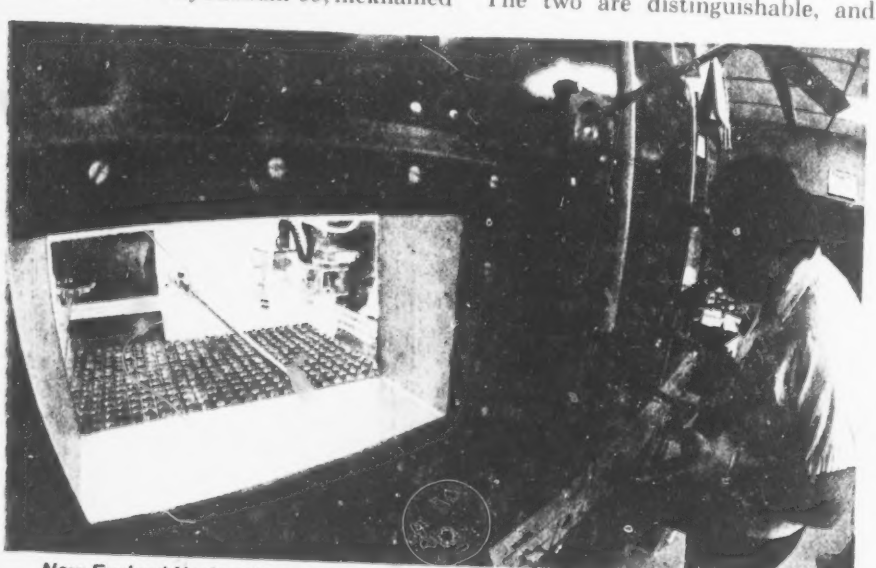
Reactor-produced isotopes have not been replaced, but cyclotron-produced isotopes have joined them. Cyclotron-produced isotopes can be tailored rationally to concentrate in certain organs or abnormal tissue. Those with short half-lives can be chosen to minimize radiation doses. Neutron-deficient isotopes can be favored, because they often decay by a desirable electron capture process rather than by electron, positron, or alpha emission. Electron capture is the capture of a K-shell electron of the atom by a proton in the nucleus to form a neutron, with emission of characteristic gamma rays.

Of 1723 g of separated isotopes sold by Oak Ridge in fiscal 1980, the most recent year for which data are available, 708 g was thallium-203 and 118 g was zinc-68. Proton bombardment of thallium-203 yields lead-201 and three neutrons. Lead-201 decays by electron capture to thallium-201, which is isolated for heart studies. Thallium-201 concentrates in heart muscle, and failure to do so reveals locations of coronary artery blockage or dead tissue from a heart attack. The two are distinguishable, and surgeons can gauge success of operations to relieve arterial blockage. Zinc-68 produces gallium-67 by a similar reaction. Gallium-67 concentrates in abscesses and tumors. Other important radiopharmaceuticals are indium-111, produced from cadmium-112, to detect leakage of cerebrospinal fluid; and iodine-123, made from tellurium-124, for thyroid function tests.

For the future, the easily controllable chemistry of iodine may lead to increased demand for iodine-123, which has a half-life of only 13 hours, to label such compounds as fatty acids, which concentrate in the heart. These developments will lead to increased demand for separated tellurium-124. Mallinckrodt is developing gold-195m, whose half-life is a scant 30.6 seconds, to image blood but not heart muscle for measurement of pumping action and titration of drug doses against abnormal rhythms. The gold-195m will come from a generator containing mercury-195m. Mallinckrodt has not yet decided how to produce mercury-195m, but if the company chooses bombardment of gold-197, the natural abundance of that isotope is 100%.

Among U.S. radiopharmaceutical makers, New England Nuclear is the leader with estimated 1982 sales to that market of $45 million. Du Pont acquired the company in 1981. NEN was the first U.S. producer to put in its own cyclotron, in 1970 at Billerica, Mass. In addition to four cyclotrons now at Billerica, New England Nuclear will start up the first U.S. commercial linear accelerator there this fall. The 200-ft, 45-MeV, 5-milliampere accelerator, which cost $15 million, has the production capacity of eight 30-MeV cyclotrons, which would have cost $4 million to $6 million each.

The second-ranking producer is Mallinckrodt (acquired by Avon this year) with estimated 1982 sales of $35 million. The company started cyclotron production in Petten, the Netherlands, in 1978 upon acquiring the business and machines of Philips-Duphar for its Byk-Mallinckrodt joint venture with Byk-Gulden of Konstanz, West Germany. In 1980, Mallinckrodt signed an agreement with Medi Physics, Emeryville, Calif., to produce thallium-201 with the Medi Physics cyclotron in Chicago. That agreement ended early this year, after Mallinckrodt started up its own 30-MeV cyclotron in St. Louis. The company plans to turn on a second 42-MeV machine there this summer.



New England Nuclear technician uses remote handling apparatus behind lead shielding to dilute a radiopharmaceutical to the desired concentration

Medi Physics, which is a subsidiary of Hoffmann-LaRoche, is in third place with estimated 1982 radiopharmaceutical sales of $30 million to $35 million. The company started cyclotron production in 1971 and now has one in Emeryville, two in Chicago, and one in South Plainfield, N.J. Medi Physics dispersed its machines in this way to be as close as possible to customers of such very short-lived radioisotopes as iodine-123 (13 hours) and krypton-81m (13 seconds) for lung ventilation studies. The firm bought Union Carbide's Cintichem radiodiagnostics business, centered on a reactor at Tuxedo Park, N.Y., in 1981. Carbide kept the reactor to operate for Medi Physics, because U.S. law makes the Swiss parent ineligible to operate a reactor here. Carbide also sells such products as fission moly and xenon-133 to others.

The fourth major U.S. radiopharmaceuticals supplier is E. R. Squibb & Sons, Princeton, N.J., with estimated 1982 sales of $15 million to $20 million. The company does not produce radioisotopes, but sells kits that can be labeled with technetium-99m generators.

Besides the Union Carbide reactor at Tuxedo Park, the only other commercial source of reactor-produced isotopes in North America is Atomic Energy of Canada Ltd., which has two reactors at Chalk River, Ont. Customers can send targets to be irradiated to the University of Missouri, Rolla, as well.

In addition to target irradiation, AECL's reactor design allows use of cobalt control rods, which build up large amounts of cobalt-60 in use. Canadian exports of cobalt-60 to the U.S., expressed in curies, are growing at the rate of 33% annually for such uses as sterilization of medical supplies and fabrication of thickness gages. A curie is the amount of radioisotope that yields 3.7×10^{10} disintegrations per second.

From 1957 to 1978, General Electric's Vallecitos Nuclear Center, near Pleasanton and Sunol, Calif., produced 90% of U.S. reactor isotope needs. Shut down in 1978 because of the discovery of a seismic fault nearby, the reactor has not received approval for restarting.

AECL will begin marketing finished radiopharmaceuticals in Canada this July, according to Brian Armstrong, general manager of the new radiopharmaceuticals products group. This move will put the crown corporation into competition with Merck Frosst Canada, Montreal, and imports from New England Nuclear. AECL has no current plans to market in the U.S., Armstrong explains, because of heavy investment needed to secure New Drug Applications (NDAs) from the U.S. Food & Drug Administration, a U.S. sponsoring partner, and a distribution system here. The first products out in July will be technetium-99m generators and single-dose forms of xenon-133. By October, AECL will be selling thallium-201 and gallium-67, following installation of a 42-MeV cyclotron at the TRIUMF accelerator site at the University of British Columbia, Vancouver, in which AECL is a participant. AECL will depend on Oak Ridge for thallium-203 and zinc-68 raw materials, and has no plans to separate such isotopes itself.

Supply of separated isotopes of 11 lighter elements and the inert gases is plentiful. Some isotope markets here have attracted private firms. DOE's Savannah River plant, Aiken, S.C., operated by Du Pont, shut down its 100 ton-per-year heavy water plant in December 1981, but still produces tritium. Isotopes of lithium and boron are separated by Eagle-Picher Industries at Quapaw, Okla. DOE's Mound Facility, Miamisburg, Ohio, operated by Monsanto Research Corp., separates isotopes of chlorine, sulfur, and the inert gases. In 1979, two Mound employees, Roger Schwind and Vincent Avona left to form Isotec, Centerville, Ohio, which separates inert gas isotopes. The company will add carbon isotopes to its line in 1983. Because DOE's policy is not to compete with private firms, Mound has withdrawn from the rare-gas isotope market, except for sales to DOE and holders of DOE contracts and grants. Mound probably will get out of carbon isotopes sales to others than DOE in 1983. Carbon, oxygen, and nitrogen isotopes are separated at Los Alamos National Laboratory, operated by the University of California, and distributed through Mound.

The Savannah River heavy water plant, which could be restarted if needed, uses the Girdler sulfide process. Hydrogen sulfide percolates upwards past sieve and bubble cap trays in a series of columns against a downflow of water. Passage through four columns yields water with 4 to 5% deuterium. Vacuum distillation completes enrichment to greater than 99%.

Production methods and amounts of tritium at the Savannah River plant are classified. Reaction of lithium-6 with neutrons produces tritium and helium.

Eagle-Picher separates lithium isotopes by an exchange extraction of aqueous lithium hydroxide from lithium amalgam. Lithium-7 tends to concentrate in the amalgam. It is

U.S. radioisotope imports increase . . .

Year[a]	Cobalt-60 Quantity (1000 curies)	Cobalt-60 Value ($ million)	Other Quantity (1000 curies)	Other Value ($ million)	Total[b] Quantity (1000 curies)	Total[b] Value ($ million)
1981	8341	$6.4	217	$20.7	8558	$27.2
1980	6806	5.0	80	19.0	6886	24.0
1979	5893	3.9	84	16.2	5977	20.1
1978	3534	2.7	93	18.8	3627	21.9

. . . but export value remains much larger

Year[a]	Drugs[c] Quantity (1000 curies)	Drugs[c] Value ($ million)	Carbon-14 Quantity (1000 curies)	Carbon-14 Value ($ million)	Cobalt-60 Quantity (1000 curies)	Cobalt-60 Value ($ million)	Other Quantity (1000 curies)	Other Value ($ million)	Total[b] Quantity (1000 curies)	Total[b] Value ($ million)
1981	9.4	$36.2	0.2	$3.5	0.2	$1.1	44.0	$47.6	53.7	$88.4
1980	4.5	31.6	0.1	2.9	0.7	0.6	33.4	36.3	38.7	71.3
1979	14.0	27.4	0.1	2.2	5.0	0.4	35.9	28.3	55.0	54.5
1978	18.4	15.7	0.9	2.4	46.9	1.3	64.9	31.5	116.6	50.9

a Calendar year. b Sum may not equal totals because of rounding. c Includes cobalt-60 for medical uses. Source: Bureau of the Census

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Glass dominates U.S. soda ash use

Millions of tons	Soda ash
Glass	3.91
Glass container	2.77
Flat glass	0.65
Glass fiber	0.21
Other	0.28
Chemicals	1.32
Detergents	0.52
Pulp	0.25
Water treatment	0.25
Other	0.35
Exports	1.10
TOTAL	8.30

Source: FMC Corp.

as the 1980s began, and more is coming. In addition, technology development through solution mining of raw material trona ore could reduce mining and processing costs. At the same time, glass, the major use of soda ash, is threatened increasingly by plastics. These factors all will tend to lower the relative price for soda ash.

The upshot, Shamel forecasts, will be a growing differential in selling prices of these sodium oxide sources. He estimates that caustic soda prices will increase 2 to 3% annually in real dollars; soda ash prices will rise zero to 1%.

Other economic factors also influence conversion possibilities and are very site-specific. Among them, for example, are delivery prices for caustic soda and soda ash, volume of use, capital investment needed for conversion, and any associated operating costs differences.

Some conversion already has occurred, especially by producers of inorganic sodium compounds, such as detergent phosphates. As of the end of 1981, Shamel estimates that 400,000 tons of annual consumption of caustic soda has been converted to soda ash. He forecasts that by 1990 the conversion could reach 1.5 million tons of annual consumption. This quantity would be about 10% of his estimated 1990 capacity for caustic soda.

Shamel's view is shared, although with more conservative figures, by FMC, the largest soda ash producer. Conversion potential would reach 230,000 tons annually by 1986 as chlorine demand grows 1.0% per year and caustic 1.3%, estimated James T. Lowe, Charles W. Raleigh, and Andrew F. Zeller of FMC at the Chemical Marketing Research Association's meeting in New York City earlier this month.

Besides inorganic compounds, other areas of potential conversion foreseen by Shamel are neutralization of process and waste streams, scrubbing of process and off-gases, water treatment, pulp and paper manufacture, and alumina production.

Not all uses of caustic soda may be practical to convert to soda ash, Shamel adds. For example, the chemical reaction involved may require caustic soda for thermodynamic reasons. Or soda ash may not provide a high enough pH. Evolution of carbon dioxide during a neutralization with soda ash could be undesirable. And the carbonate ion from soda ash could cause unwanted side reactions or other process complications.

In neutralization uses—next to detergent phosphates the most likely area for conversion—one of the major drawbacks will be relatively high capital investment. Such investment would go largely for equipment to dissolve soda ash, since many current neutralization sites use liquid caustic soda. Liquid soda ash, however, recently has become available commercially.

Pulp and paper manufacture are the next most likely candidates for conversion. Rough economics might be like this: At a southern paper mill, caustic would be delivered for $280 per ton for an annual use of 5000 tons. Soda ash might be delivered for $140 per ton, or $186 per ton of caustic equivalent. An investment of $120,000 might be needed for receiving, transferring, and dissolving equipment.

The operating penalty with soda ash would be $30 per ton converted. Material savings with soda ash would be $220,000 a year (5000 times $230 minus $186). Net variable cost savings with soda ash would be $70,000 a year ($220,000 minus 5000 times $30). The payout time on the investment would be about 1.7 years ($120,000/$70,000).

For some uses, soda ash is currently an economic substitute for caustic soda. But conversion is held back by inertia, a dislike by users for solids handling, or a belief that high caustic prices are temporary, Shamel says. However, he predicts that economic incentives are increasing and will bring more and more conversion as the 1980s proceed. □

Mobil to offer new monomer for plastics

Is the world ready for a new styrene? And if it is, for what applications? That's what Mobil Chemical is asking as it nears startup, this fall, of a plant to make *p*-methylstyrene, the hottest "new" product to surface in the highly competitive world of monomers for plastics. Mobil will produce its *p*-methylstyrene in a plant owned jointly with American Hoechst, in Baton Rouge (C&EN, May 24, page 15); capacity is set at 35 million lb per year.

Methylstyrene actually has been around for a long time, although it usually is called vinyltoluene—an umbrella name for a combination of the meta- and para-isomers. Dow Chemical, for example, has been producing and marketing vinyltoluene since the 1950s, and now has capacity at Midland, Mich., of 70 million to 90 million lb per year. And last year, Cosden Oil & Chemical began commercial production of vinyltoluene in Big Spring, Tex., with capacity of roughly 40 million lb per year.

Total worldwide market demand for vinyltoluene is estimated at about 100 million lb per year, in specialty applications. That's a tiny market compared to the 6.61 billion lb of styrene produced in the U.S. alone last year. Up to now, however, potential markets for methylstyrene have been held back by the difficulty of obtaining the isomer desired.

The key to Mobil's new process is its proprietary zeolite alkylation catalysts, which control formation of the methylstyrene so closely that the process yields as much as 97% para-isomer. The company "has not yet established a commercial licensing policy," a spokesman says.

With a 35 million lb-per-year plant, Mobil and Hoechst are just dipping their toes into the water. Some industry observers feel that if marketers are going to make a serious dent in the styrene business, even with a monomer that promises better polymer performance, as *p*-methylstyrene does, it will take a major effort. That's the assessment, for example, of John D. DeWitt, president of Houston consultants DeWitt & Co., who predicts that if someone takes "the enormous risk of building a world-scale poly-*p*-methylstyrene unit," to bring economies of scale into the process, poly-*p*-methylstyrene can capture as much as 400 million lb of the total polystyrene market by late in this decade. □

action in the May 20 *Congressional Record*. There he said that "existing unserviceable lethal chemical artillery shells are not to be renovated and are to be demilitarized [neutralized] when practicable." Excluded from the one-to-one replacement scheme are those munitions "designated 'unserviceable' in the Army's June 1981 report on the chemical stockpile," he explained.

The Defense authorization bill now moves to the House. The House Armed Services Committee has not announced floor action, but the bill is expected to come up for a vote within the next six weeks. A Hart-type amendment deleting chemical weapons production funds is expected to be offered by Rep. Toby Moffett (D.-Conn.) and others. Like the Hart amendment, it is not expected to pass. The final Senate version on chemical weapons, in fact, is expected to prevail.

The next, perhaps significant, skirmish will be at the appropriations level. There, Hatfield will manage the bill, and bring to that effort his abhorrence of chemical warfare which will inflict, he says, greater casualties on civilians than on military personnel in protective gear.

Hatfield will be supported by those who for other reasons wish to see a ban on these weapons. One is Sen. Dennis DeConcini (D.-Ariz.), who supports a strong military, but who has "no reason to believe that the actual production of binary chemical weapons will do any more to stop the Soviets from using these weapons or to bring them to the bargaining table in a frame of mind which would lead to the abolition of these weapons than would the threat that the U.S. is in a position to produce such weapons without delay." DeConcini already has supported a Senate resolution calling on the Administration to reinitiate chemical arms talks with the Soviets. □

Waste treatment firms handling less volume

A survey conducted for the Environmental Protection Agency of major hazardous waste management firms shows that, although they managed to increase revenues 20% in 1981 over the previous year, the volume of wastes handled actually declined. And though none of the surveyed firms' facilities were closed completely during 1981, several had certain portions of their operations, such as landfills, closed because of public opposition or compliance problems. Some other facilities required major capital expenditures to comply with federal or state regulatory requirements but were able to remain open.

The nine firms surveyed by Booz, Allen & Hamilton Inc.'s energy and environment division account for more than 50% of all commercial waste disposal and treatment. The firms are: Browning-Ferris Industries, CECOS International, Chem-Clear, Chemical Waste Management, Conversion Systems, IT Corp., Rollins Environmental Services, SCA Chemical Services, and US Ecology. The new survey is an update of one done in 1980.

In 1980 the nine firms operated 36 of the 127 identified hazardous waste facilities; in 1981 that number was up to 46. But of the 10 additional facilities only three belonging to Chem-Clear were totally new. The others represent acquisitions of existing firms. Nevertheless, the nine firms increased their permitted landfill capacity 46% and their chemical treatment capacity 18%. But the report notes these capacity increases do little to diminish potential regional capacity shortages identified in the 1980 survey because not only were many of the capacity additions transfers of ownership but most of the others represent expansion at existing sites in regions that had the greatest capacity to begin with. Many of the firms are continuing to pursue new landfill sites but report that public opposition remains as intense as ever.

Despite the increased capacity the volume of wastes treated by the nine firms actually declined from 3.7 million wet metric tons (WMT) in 1980 to 3.6 million WMT in 1981. The report attributes this reduction to a number of factors. One is the recession. Many of the industries hardest hit, such as auto, steel, and the metal fabricating industries, also are major users of commercial treatment and disposal, but now are generating less waste.

Another factor is the huge price increases—at certain facilities increases of more than 50%—that occurred in 1979 and 1980 for hazardous waste management services and made many waste-reducing options that were only marginally economic in 1979 clearly economic in 1981. Generators now are more careful, the report points out, to segregate hazardous from nonhazardous waste for disposal or are reducing waste generation by raw material substitutions. In addition, some of the major generating industries have been successful in having some large-volume waste streams, such as certain paint sludges and pickle liquor sludges, taken off the hazardous waste list.

One additional factor cited by the report is that many large chemical companies have reduced their reliance on off-site facilities substantially over the past several years and are striving for 100% internal waste management to minimize liability problems, maintain production controls, and avoid off-site disposal costs.

And these costs did go up in 1981 with price increases averaging 15%. But, as the report points out, these increases are well below those of 1979 and 1980 that virtually doubled the cost of off-site hazardous waste disposal and treatment.

What this new study indicates, says Alan Farkas, a Booz, Allen vice president who directs environmental studies, "is that if volumes received do not strongly recover after the recession ends, waste management firms will have to offer a broader range of services to sustain growth and earnings." □

Firms increase capacity, but have less waste to handle

Type of waste management	Capacity[a] 1981	Capacity[a] 1980	Capacity[a] % change	Volume received[a] 1981	Volume received[a] 1980	Volume received[a] % change
Landfill	37,372	25,672	46%	1965	2182	−10%
Land treatment/solar evaporation	1,400	1,447	−3	282	300	−6
Chemical treatment	1,305	1,105	18	734	544	35
Deep-well injection	1,095	1,095	0	475	475	0
Resource recovery	341	341	0	83	83	0
Incineration	102	102	0	80	85	−6
TOTAL	41,615	29,762	40%	3610	3669	−1%

a Thousands of wet metric tons. Source: Booz, Allen & Hamilton Inc.